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Fresh Water Sponges and Particularly Those of the United States.

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In the beginner's class of Zoology there is invariably noticed a doubting expression of surprise when it is announced that the next subject to study is the Fresh Water Sponge. I fancy I can see the same expression on the face of those of my readers who may doubt that sponges are found in the nearby brook, river or lake. To be sure, such sponges as the average man knows about, and which he can buy in the nearby drug store, are not to be looked for in our ponds and ditches; they must be sought in the far away Mediterranean Sea or down on the coasts of the Bahamas or on the Keys south of Florida.

There are many kinds of sponges — just as there are many kinds of roses or violets. This comparison reminds me also of the necessity of stating that sponges are not vegetable growths, as was once believed even by all the scientists and is still believed by many otherwise well educated people. It was in the middle of the 19th Century that it became definitely settled that sponges belong to the animal kingdom. They are now very often placed by themselves into a proper phylum called Porifera though some had placed them formerly with the Protozoa as compound Choanoflagellata, and many at present associate them with the phylum Coelenterata. Very little attention is to be paid at present to the various systems of classifications in vogue. They are all transient and provisional, and this is the most annoying condition of Zoology to the beginner. He takes up one text-book after another and he finds in each a different system of classification; and it is wise in the part of the teacher to show him from the beginning, that classification of animals is not after all the important

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work of the Zoologist, the important thing in a man's library is not where his books are placed—provided he knows what they contain. It would be loss of time for me to enter here upon a discussion of the various systems of classification with reference to the Porifera, whether it should be natural or artificial; phylogenetic or morphological is of no consequence for the moment. Those of my readers that want this kind of thing can find it in the classical works of Bowerbank, Oscar Schmidt, Zittel, Gray, Carter, Hæckel and Vosmaer. For my part I believe that Professor James Hornell, of the Jersey Marine Biological Station, has chosen the form of classification best adapted to my purpose: In Vol. I., No. 2, February, 1894, of "The Journal of Marine Zoology and Microscopy" page 39, he formulated the following system:

PHYLUM:—PORIFERA.

Branch A, *Calcarea*	Branch B, *Non-Calcarea*
Family I.—Asconidae.	Class I.—(Skeleton siliceous) Silicispongiae.
" II.—Syconidae.	Order I.—Monaxonida.
" III.—Leuconidae.	" II.—Tetractinellida.
(Characterized respectively by the Canal system indicated by the name.)	" III.—Hexactinellida.
	Class II.—(Skeleton fibrous) Ceratosa.
	Class III.—(Skeleton none) Myxospongiae.

The Calcarea are recognized by the chemical composition of their so-called skeleton. This skeleton is in the form of needles and spines of various forms, but invariably their animal matter is highly or almost completely impregnated with calcium carbonate, and can easily be verified by subjecting them to any mineral acid, which will disolve them with effervescence. They are all marine and therefore do not concern us in this study.

The non-Calcarea include, as may be seen from the table above, three kinds or classes. In the first class are included all sponges that have spicules of a siliceous or glassy composition. In the second, we find those sponges whose skeleton consists of a horny fibrous network, (sponge of commerce), and the third class includes those that have no skeleton and wholly consist of soft animal matter.

The reader will notice that the siliceous sponges are sub-divided into three orders and these orders are again based on the form of the spicules. In the first order the glassy needles are simple rods or needles. In the second the spicules consist of four needles

radiating from one point and in the third order the radiating needles are six. Now comes the all important question in this study. Where shall we place the Fresh Water Sponges? If we follow Hornell's classification the question is simple. In all Fresh Water Sponges the spicules are siliceous and of the monaxial type, and so they must belong to the class of Silicispongiae and to the order of Monaxonida.

Vosmaer places the Fresh Water Sponges into the third order of the Non-Calcarea which he calls Cornacuspongiae; and he gives the following diagnosis: "Skelet besteht entweder aus, vorwiegend, monaxilen Spicula, welche durch mehr oder weniger spongin zusammengekittet sind, oder nur aus spongin mit oder ohne Vestärkung von Fremdkörpern. Leben in See,—brackischem und Süss-wasser meist nicht sehr tief." Translated this means that in the Cornacuspongiae "the skeleton consists principally of monaxial spicules which are cemented together more or less by spongin, or the skeleton consists merely of spongin with or without strenghtening of foreign bodies. They are found in salt water—brackish water—or in fresh water and not at great depths." Thus we see that Vosmaer places the Fresh-Water Sponges in the same group as the ordinary commercial sponges which are all marine; he however separates them from each other by creating two sub-orders viz.: the *Halichondrina*, in which the fresh-water sponges are found forming the second family called Spongillidae, and the *Ceratina* which include the commercial sponges as Family two, viz.: Spongidae.

I need scarcely say here that the prospective student will find no difficulty whatever in identifying the Fresh Water Sponges. Fresh Water Sponges properly so called are only found, as a matter of fact, in fresh water, all other sponges are found in the sea, and so whenever a sponge grows in fresh water one need have no fear of making a mistake as to identity. Let this be the guide for the beginner and after he has found a few Fresh-Water Sponges and studied them with the low power or high power of the compound microscope he will gain the knowledge to distinguish them from marine forms. There are difficulties in the study. There are so many things growing in fresh water, but one should not be discouraged, for the matter is not as difficult as it seems. First one must get over the idea that everything green in the water must be a plant—an alga or some moss. The former one will at once reject when one sees that it consists of simple or branching green threads and the latter has small green leaves which even one-inch hand lens will make plain. All one needs in the field is a hand lens of one inch

focus and one cannot go wrong. Of course, the first question naturally is: "Where shall I look for them, and how can I tell when I have found a Fresh Water Sponge?"

One will soon find that many of the troubles are imaginary ones, as to my own surprise I found them more readily than I had expected, and having found them, I knew they were what I was looking for in spite of the difficulties I had anticipated.

It was in the middle of September many years ago that I set out for the banks of the St. Joseph River in Northern Indiana. The banks were steep and some old stumps of trees were scattered along the shore, with their twisted roots reaching out in all directions. I soon noticed in the swift current that on some of the roots were greenish looking tufts—I secured a few of them, and hardly had I touched them, when I knew I had found what I had been looking for. The sponge mass is not the same as Cladophora. One will know it at once and will never forget it. Under the hand lens one will see the little needle-like spicules sticking out in all directions, but more than this in the interior of the mass one notices the small round globules, so characteristic of the Fresh Water Sponges. These globules are the gemmules and whenever these small globules are found in a greenish mass one may be sure that the specimen is a sponge. It is needless to look for sponges in the spring time, but one will never fail to find them later in the year and especially in August and September.

These gemmules are bodies peculiar to Fresh Water Sponges, and have never been found in salt water forms. They are known in the literature of sponges as: Ovaria, gemmules, statoblasts, statospheres, sphaerules, etc., but at present the term "gemmules" is mostly used. I stated above that one must look for greenish masses, but this must not be taken to mean that the color is always green; the fact is they are often brown, gray and white according as they are more or less exposed to the light. Though a few have been found in muddy localities, they must, however, as a rule be sought in clear, pure and rapidly running water. A favorite locality is in shallow water of rivers, and they grow on loose stones, but one seldom fails to find them on rocks, timber, or loose boards at the end of a mill race or fall, or on the lining board and casings of sluice-ways. They should never be looked for in shallow waters that have a muddy bottom.

Sometimes they may be found on plants growing in lakes and they will spread over these plants like a thick cobweb or cushion. A long pole with a scraper attached to the end in connection with

a bag made of netting can be used advantagously in bringing them up from timber as piles driven into the rivers near dams etc. Sometimes a mill race is emptied for repairs or a reservoir of water works for the purpose of cleaning, and then is the time to search for sponges among the rocks and timber.

Always collect them preferably from timber as they can more easily be removed by slicing off chips or splinters and they are secured without too much injury. The gemmules which are deep within will not be lost.

Young sponges such as are collected late in Spring or early in Summer will not have gemmules and, although useful to collect at all seasons, yet if for the purpose of determining the genus and species they must be collected not earlier than July. If the student's purpose is only to gather them as a collector, then he may transfer them directly into 50 per cent. alcohol or better 35 per cent. and when he gets home after some hours transfer them to stronger alcohol. Others may be placed in shady places to dry, and to prevent decay, they should be turned over at short intervals. In no case should they be left in water for any length of time as they will rapidly decay. If one wishes to study their life action they must be transferred as quickly as possible to shallow glass dishes. To demonstrate the circulation of water through the sponge mass a solution of carmine is made in pure water. After having placed the fresh living sponge into a suitable dish and covered well with water a small amount of the carmine solution is taken up with the pipette and gently emptied over one part of the sponge—soon the carmine colored water will be seen to disappear into the mass drawn in by a suction movement, and shortly after the carmine colored water will be seen to be ejected like diminutive clouds from minute chimney-like structures. This circulation is caused by the flagellated cells that line the canals in the mass. One can also watch the development of the gemmules by securing eight or ten of them and place them in a shallow watch glass with water, and cover them with a piece of glass to prevent evaporation—should this take place to some extent, one can easily add with a pipette very gently some pure water. The watch glass is placed near a window not too much lighted, and in a few days the growth can be examined under a compound microscope with a three-quarter inch lens, or with a water immersion lens of a higher power.

The student may take some of the fresh material and place a bit of it on a slide and examine it, but he will find that a bit of thoroughly dried material mounted directly into Canada balsam

will prove more satisfactory. If he has the conveniences of a biological laboratory at his disposal, he will want to make sections, and this does not present difficulties that would prove unsurmountable. A bit of the alcohol specimen may be stained with borax carmine and imbedded in celloidin and good sections may be made with an old microtome blade. The siliceous or glassy spicules will certainly spoil somewhat his best knife, but then in every laboratory there are a few knives reserved for just such kind of work. I have even made fair free hand sections of the gemmules, that will show the arrangement of the birotulate spicules which form the rather thick wall of these objects.

In examining a bit of sponge under the microscope, we will at once notice two structures viz., the skeleton part and the sarcode or fleshy part. The fleshy portion is supported by a siliceous framework made up of fine delicate, needle-like spicules—these spicules are about one-hundredth of an inch in length and pointed at both ends as a rule; in some species the spicules will be found to be covered by minute pointed projections and giving them a thorny appearance. The shape, size and appearance of these spicules help to determine the species. Besides these skeletal spicules there are others somewhat different in appearance and they are found in the dermal layer and hence called "dermal spicules." In the walls of the gemmules are found a third kind of spicules called "birotulates," these are somewhat of the shape of dumb-bells, but the ends instead of being knobs are either circular disks, or toothed disks or even a circle of kooklets. These birotulates are very important in classification. Carter selected them as the basis for the diagnosis of the genera of Spongillidae.

In order to determine the genus and species of any Fresh Water Sponge, there should be made four microscopic preparations:

The first is to examine a small piece of the dried sponge mounted directly in balsam.

The second is a similar preparation of the dermal portion to study shape and form, presence or absence of dermal spicules.

The third preparation consists of the gemmules for examination both in their normal state and in a cleared preparation. This latter preparation is made by placing a mass containing eight or ten gemmules on a slide and applying some hot nitric acid to it—this will remove most of the sarcode. Care is to be taken not to leave the acid too long as it will also attack the chitin of the spicules. After the acid has acted for a time, it may be washed out a number of times by applying alcohol and then absolute alcohol, xylol and finally mount in balsam.

The fourth and last preparation needed is easily made and it is done by the general method of cleaning diatoms—polycystina or sponge spicules. Take a test tube and put into it some of the material, add some nitric acid and boil gently over flame. After the material is completely disintegrated add water to fill the test tube, and set aside for an hour and the spicules will settle to the bottom, where they will form a sediment. Pour off carefully or with a long pipette, remove the water without disturbing the sediment. Wash thus several times to remove acid, alcohol may be used the third time as it hastens the next process.

Take with a pipette a small quantity of the sediment and place a drop of it on the middle of a clean slide. Let it dry completely and pass the slide through a flame. Finally put on the balsam and cover and you have a permanent preparation of all kinds of spicules contained in the sponge.

There remains for me only to note here all the species that have been so far observed in North America, I shall enumerate first all the genera so far observed in the whole world, secondly, I shall give the number of species belonging to each genus, and mention all the North American species in each genus. An abreviated and slightly modified key to the Genera of Fresh Water Sponges according to Potts–Carter System may be stated as follows:

A Fresh Water Sponges with gemmules.

I. Gemmules with arotulate spicules.

1. Gemmules surrounded by simple thorned spicules which are pointed or rounded at ends. . SPONGILLA.

II. Gemmules with birotulate spicules.

1. Birotulate spicules of one class or type and rotules equal or nearly so. . . . . MEYENIA.

2. Birotulate spicules of two classes or types—the smaller number of them longer and rotules hooked. HETEROMEYENIA.

3. Birotulate spicules with rotules unequal. . TUBELLA.

III. Gemmules with unirotulate spicules.

1. Spicules forming capsule of gemmules with only one rotule other end merely pointed. . . . . PARMULA.

IV. Birotulate spicules of no consequence. The foraminal tubules of the gemmules more or less prolonged and terminating in a funnel-like expansion or divided into thread-like appendages varying in length and number. . . . . CARTERIUS.

B. Fresh Water Sponges in which gemmules have not been found.

Provisionally there are three genera:

Uruguaya, *Lubomirskia* and *Potamolepis.*

Of these nine genera of Fresh Water Sponges the following five are represented in North America: Spongilla, Meyenia, Heteromeyenia, Tubella, and Carterius.

Parmula with three species has thus far only been reported from South America.

Uruguaya with one species is reported from the rapids of the River Uruguay, near the town of Salto.

Lubomirskia with four species has only been reported from Lake Baikal, Central Asia.

Potamolepis with three species has only been reported from the Congo River, Africa.

We may now proceed to the study of the North American species of the five remaining genera.

I. Genus *Spongilla* Lamarck, 1815.

It is well known that the ancient authors placed all the Fresh Water Sponges into the genus Spongilla, and Mr. Potts claims that Carter is the founder of the genus as it stands to-day; he says on page 182 of his Monograph, "When the old genus *Spongilla* of authors was subdivided by Mr. Carter in 1881, this term was very appropriately restricted to that type which includes the species most widely diffused and most frequently noticed throughout the world." Therefore the genus may read:

Genus, *Spongilla*, Carter. 1881.

Under this genus Potts enumerates 17 species some of which exhibit varieties.

Among these species five are North American, viz.:

1. *S. aspinosa.* Potts.
   Loc. New Jersey swamps.
2. *S. lacustris.* Linn. Widely known as the commonest F. W. Sponge. He gives the following varities: *paupercula*, *lawsoni*, *abortiva*, *montana*, *multiforis and lehighensis.*
3. *S. fragilis*, Leidy. This is reported from many localities in U. S. A., and it has many varieties. One variety called calumeti; Thomas, is reported from the Calumet River, near Chicago.
4. *S. mackayi*, Carter, from Nova Scotia.
5. *S. terrae-novae*, Potts, from Newfoundland.

II. Genus, *Meyenia*, Carter, 1881.

This genus includes 17 species not counting a number of varieties. Seven of the species are North American.

1. *M. leidyi*, Carter, so far only found at Philadelphia and in New Jersey.
2. *M. fluviatilis*, (*Spongilla fluviatilis*, of authors) found in all parts of U. S. and in many varities.
3. *M. robusta*, Potts, from California.
4. *M. millsii*, Potts, from Florida.
5. *M. subdivisa*, Potts, from Florida.
6. *M. baileyi*, Bowerbank. West Point, N. Y.
7. *M. crateriformis*, Potts. Pennsylvania.
8. *M. everettii*, Mills. Gilder Pond, Mt. Everett, Mass.

III. Genus, *Heteromeyenia*, Potts, 1881.

In this genus Potts enumerates four species with a few varieties, all of which are only so far reported from the U. S. A.

1. *H. repens*, Potts, reported from Lehigh Gap, Pa., Lake Hopatcong, New Jersey, and along the Eastern Coast.
2. *H. argyrosperma*, Potts, from Lehigh Gap, Pa., New Jersey, and New England States.
3. *H. longistylis*, Mills. Sponge unknown but gemmules collected by Dr. Wolle at Bethlehem, Pa.
4. *H. ryderi*, Potts. This sponge is reported from Florida to Nova Scotia and from Atlantic Coast to Iowa. I found it in St. Joseph River, Indiana.

IV. Genus. *Tubella*, Carter, 1881.

In this genus, we find five species, one of which is represented in U. S. A. The other four being found in the Amazon River of South America.

1. *T. pennsylvanica*, Potts. It is found in Lehigh River and generally throughout Eastern U. S.

V. Genus, *Carterius*, Potts 1881.

This genus contains four species, three of which are found in the United States of America. The fourth being found in Russia and in Bohemia, but Carter claims that the Russian species is identical with species *C. tenosperma* of America.

The American species are:

1. *C. tubisperma*, (*!*) Mills, and was found on timber in the Niagara River, N. Y., and also in a reservoir in Boston, Mass.

2. *C. latitenta*, (*!*) Potts, found in Chester Creek, Pa., and in Western New York.
3. *C. tenosperma*, (*!*) Potts. First found by Mr. Potts in a rill at the Centennial Fair Grounds, Philadelphia, and later in New Jersey.

In conclusion let me state that the principal object in writing this communication for the Midland Naturalist is to stimulate students in its territory in the study of Fresh Water Sponges; I would like to see all localities in its territory where any of the species are found, reported in these pages.

Bibliography. *Bowerbank*, Monograph of Spongillidae 1863.

Carter, History and Classification of the known species of Spongilla, 1881.

Potts. Fresh Water Sponges, A Monograph. Proceeddings of Academy of Natural Sciences, Philadelphia, 1887. This Monograph is indispensable for the study of American Fresh Water Sponges.

It covers the whole ground of Fresh Water Sponges and gives special facilities for the determination of all American species as far as known.

Vosmaer, Klassen und Ordnungen der Spongien. (Porifera) 2nd vol. of Bronn's, Klassen und Ordnungen des Thier-Reichs.

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Tentative List of Myxomycetes of Northern Indiana and Southern Michigan.

L. BARBAZETTE.

The following list of the Myxomycetes of northern Indiana and southern Michigan represents only part of those actually observed in this locality, and only those species are mentioned which are at present found in the herbarium of the University. They were collected by Dr. J. A. Nieuwland of the botanical department of Notre Dame University, during the months of July and August in the year 1905. Favorable conditions for growth, warm weather followed by periodical rains, were prevalent at that time and many of the plants that were developed then have not been seen since.